Department of Mechanical Engineering
B.I.T., Mesra, Ranchi
M.Tech (Energy Technology) Course Structure

Course Code No	Course Title	L	T	P	CREDIT
1st Semester					
ME541	Renewable Sources of Energy	3	0	0	3
ME542	Fuel Technology	3	0	0	3
ME543	Energy Conversion System	3	0	0	3
ME549	Energy Simulation and Modelling	3	0	0	3
Program Elective (PE I)					
ME544	Wind Energy	3	0	0	3
ME545	Solar Passive Architecture	3	0	0	3
ME546	Hydrogen Energy System	3	0	0	3
Laboratories					
ME547	Energy Laboratory I	0	0	4	2
ME548	Computational Lab	0	0	4	2
Total					**19**
2nd Semester					
EE597	Power Generation, Transmission and Distribution	3	0	0	3
ME553	Economics and Planning of Energy Systems	3	0	0	3
ME554	Energy Management and Auditing	3	0	0	3
Program Elective (PE II)					
ME555	Energy Storage Technology	3	0	0	3
ME571	Convection Heat and Mass Transfer	3	0	0	3
ME557	Integrated Energy System	3	0	0	3
Program Elective (PE III)					
ME550	Bioconversion and Processing of Waste	3	0	0	3
ME551	Solar Photovoltaic System	3	0	0	3
ME552	Nuclear Energy	3	0	0	3
ME559	Energy, Ecology and Environment	3	0	0	3

	Laboratories				
ME558	Energy Laboratory II	0	0	4	2
Total					**19**
3rd Semester					
ME600	Thesis Part-I				8
Open Elective (OE)					
	OE I/MOOC I	3	0	0	3
	OE II/MOOC II	3	0	0	3
Total					**14**
	4th Semester				
ME650	Thesis Part-II				16
Total Course Credit of Programme					**68**

**Open Elective (OE) - Interdisciplinary

Department of Mechanical Engineering
Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate Doctoral and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized Centre of excellence in academics, research and technological services in the area of Mechanical Engineering and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently
- Developing engineers with managerial attributes capable of applying latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry

Program Educational Objectives (PEO)

PEO 1: To develop capability to understand the fundamentals of Science and Energy Technology the engineering problems with futuristic approach.

PEO 2: To foster a confident and competent post graduate capable to solve real life practical engineering problems fulfilling the obligation towards society.

PEO 3: To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.

PEO 4: To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

Program Outcomes (PO)

1. An ability to independently carry out research/investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

Programme Specific Outcomes (PSOs)

PSO 1: Apply software skills in the field of modeling, analysis and system simulation such as MATLAB, ANSYS- CFX, Fluent for performance evaluation and optimization of non-renewable/ renewable energy systems like bio, wind, solar and hybrid systems.

PSO 2: Recognize the need for lifelong learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PSO 3: The student will be employable, able to develop entrepreneurship and be equipped in applying knowledge of Energy Technology in solving various real time problems and also pursue higher studies.

Graduate Attributes

1. Scholarship of Knowledge: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

2. Critical Thinking: Analyse complex engineering problems critically, apply independent judgement for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

3. Problem Solving: Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

4. Research Skill: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

5. Usage of modern tools: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

6. Collaborative and Multidisciplinary work: Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

7. Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8. Communication: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. Life-long Learning: Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

10. Ethical Practices and Social Responsibility: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

11. Independent and Reflective Learning: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

COURSE INFORMATION SHEET

Course code: ME 541
Course title: Renewable Energy Sources
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: 01
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module-1: INTRODUCTION TO ENERGY STUDIES

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources , Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario. (8)

Module-2: SOLAR ENERGY

Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system , Solar Cookers , Solar driers, Solar Still, Solar Furnaces, Solar Greenhouse. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies.

(8)

Module-3: WIND ENERGY

Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of

wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram.

(8)

Module-4: BIOMASS ENERGY

Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass , Biomass programs in India.

(8)

Module-5: HYDRO POWER AND OTHER RENEWABLE ENERGY SOURCES

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal energy.

(10)

TEXT BOOKS:

1. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. B. H. Khan, Non-Conventional Energy Resources, , The McGraw Hill
3. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006.
4. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
5. Garg, Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill.

REFERENCE BOOKS:

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publications, New Delhi, 2011.
2. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 1996.
3. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata McGraw-Hill, 1986.

4. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
5. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
6. Frank Krieth& John F Kreider ,Principles of Solar Energy, , John Wiley, New York

COURSE INFORMATION SHEET

Course code: ME 542
Course title: Fuel Technology
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: 1
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module 1- Introduction to fuel: Different fuel energy resources, it's Indian and global perspective, Classification of Solid, liquid and gaseous fuels, Combustion appliances for solid, liquid and gaseous fuels (8)

Module 2: **Origin and formation of coal**: Different theories on coal formation, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Fundamentals of coal combustion, combustion stoichiometry, Flue gas composition, Fundamentals of coal gasification, producer gas, water gas. (8)

Module 3: **Extraction of liquid fuels**: Petroleum and its derived products, Petroleum refining processes, Interconversion of fuels, Liquid fuel resources, world and Indian statistics, methods for characterization of crude oil and its products, refinery operations, testing of liquid fuels, industrial process design, utilization of petroleum products, synthetic liquid fuels. (8)

Module 4: **Production of gaseous fuels**: Natural gases and its derivatives, sources, potential, Gas hydrates Different types of gaseous fuels and its resources and their characteristics, principles of manufacturing of gaseous fuels from coal and oil, kinetics and mechanism of gasification, production of industrial fuel gases, rich gases such as SNG, purification, storage and transportation of gaseous fuels. (8)

Module 5: **Nuclear fuels**: Oxide fuel, Metal fuel, Ceramic fuel, liquid fuel, Refused-derived fuel, Bio-fuels: Biomass, Algae, biodiesel, Alcohol Fuels: Methanol, Ethanol, Butanol, Propane, etc. (8)

Text Book

1. J.G. Speight and B. Ozum, Petroleum Refining Process, CRC Press, 2009.

2. J. G. Speight, The Chemistry and Technology of Coal, CRC Press, 2013.

Reference Book

1. F. Peter, Fuels and Fuel Technology, Wheaten & Co. Ltd., 1st edition, 1965.

2. S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.

3. J. G. Speight, The chemistry & Technology of Petroleum, 4th edition, CRC Press, 2006.

4. Ke Liu, C. Song and V. Subramani, Hydrogen and Syngas Production and Purification Technologies, John Wiley & Sons, 2010.

COURSE INFORMATION SHEET

Course code: ME543
Course title: Energy Conversion System
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: 1
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module 1:

Solar Thermal Conversion System: Relevance of solar thermal power generation; Components of solar thermal power plant, Design and performance, characteristics of different solar concentrator types suitable for thermal power generation. [8]

Module 2:

Solar Thermal Conversion System for high temperature applications:

Types of solar thermal conversion system used in high temperature application, Tracking of solar concentrators; performance characterization of solar concentrators both line focus and point focus, Comparative analysis of the both mode focus system, Optical design and concentration characteristics of line and point focus based system. [8]

Module 3:

Thermal Energy Conversion & Bio-Energy Conversion Systems: Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems, Thermionic power conversion and plasma diodes, Thermo chemical Conversion. Bio-energy conversion, bio methanation technology, Thermo chemical conversions.

[8]

Module 4:

Fuel cell Technology: Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Balance of plant, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells. [8]

Module 5:

Electric Energy Conversion System: Generation of electricity using different sources, Transmission and distribution losses, AC to DC and DC to AC conversions, Electric motors: Types, losses, efficiency, Lightning systems, Diesel generating systems. [10]

TEXT BOOKS:

1. S. S. L. Chang, Energy Conversion, Prentice Hall, 1963.

2. S. W. Angrist, Direct Energy Conversion, Pearson, 1982.

3. R. J. Rosa, Magneto hydrodynamic Energy Conversion, Springer, 1987.

4. V. S. Bagotsky, Fuel Cell Problems and Solutions, John Wiley & Sons, 2009.

REFERENCE BOOKS:

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970

2. Green M.A., Solar Cells, Prentice-Hall, Englewood Cliffs, 1982

3.Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.

COURSE INFORMATION SHEET

Course code: ME549

Course title: Energy Simulation and Modelling

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s):

Credits: 3 L:3, T: 0, P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: 03

Branch: Mechanical Engineering

Specialization: Energy Technology

Name of Teacher:

SYLLABUS

Module 1: INTRODUCTION

Energy policy analysis; need for energy modeling; classification of energy models; types of computer based tools for energy planning; national and rural energy planning; sectorial energy planning. (8)

Module 2: INPUT-OUTPUT AND ECONOMETRIC MODELS

Types and Characteristics of I-O models; use of I-O models; IO transaction tables; method of estimation and sources of data; mathematical expression on the methodology of construction of I-O tables; case studies. Statistical estimation techniques; time series; regression analysis; advantages and limitations of econometric models; elastic ties of energy demand; case studies.

(8)

Module 3: OPTIMIZATION MODELS

Linear and non-linear optimization models; advantage and limitation of optimization models; case studies of linear optimization models for national and rural energy planning (8)

Module 4: PROCESS ANALYSIS MODELS

End-use models; process analysis models for industrial, domestic and transport energy conservation; advantage and limitations of process analysis models; case studies.

(8)

Module 5: SYSTEM DYNAMIC AND OTHER SIMULATION MODELS

Concept of closed system; causal loop diagram; flow diagram and system equations; dynamic behavior of energy systems; advantages and limitations of simulation models; case studies.

(8)

Text Books

1. J.P. Weyant & T. A. Kuczmowski "Engineering- Economy Modeling: Energy Systems" Energy-The International Issue (Special issue an energy modeling), Pergaman Press. Vol. 15, No. ¾ PP 145-715, 1990.
2. Richard de Nenfville, " Applied Systems Analysis" Mc Graw Hill International Eds. 1990.

Reference Books

1. J. W. Forrester, "Principles of Systems" MIT Press, 1982.
2. Rene Codoni, Hi- Chun Park, K.V. Ramani, " Integrated Energy Planning: A Manual" Volume on policy planning, Asian & Pacific Development Center, Kuala Lumpur 1985.

Program Elective I

PE I

COURSE INFORMATION SHEET

Course code: ME544
Course title: Wind Energy
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: 01
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module I - BASICS OF WIND ENERGY TECHNOLOGY: Wind statistics- Measurements and data Presentation, Historical developments, latest developments, state of art of wind energy technology, turbine rating, economic analysis of wind turbine, Indian scenario and worldwide developments, present status and future trends. Wind turbine aerodynamics. (8)

Module II - CHARACTERISTICS OF WIND ENERGY: Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. effect of Reynolds's number, actuator disc, Betz coefficient, design of wind turbine blade, effect of stall and blade tip speed ratio and coefficient of torque. (8)

Module III- WIND ENERGY CONVERSION SYSTEM (WECS): Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations-Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System-Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters- Testing of WECS, WECS Control System - Requirements and Strategies. (8)

Module IV - CONTROL MECHANISMS: Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Wind turbine dynamics with DC and AC generators: induction and synchronous generators, variable speed operation, effect of wind turbulence. Case study of design of wind mill. (8)

Module V - WIND ENERGY APPLICATION: Wind pumps - Performance analysis, design concept and testing, Principle of WEG- Stand alone, grid connected and hybrid applications of

WECS, Economics of wind energy utilization, Wind energy in India- Case studies, environmental impacts of wind farms. (10)

TEXTBOOKS

1. Steve Parker, “Wind power”, Gareth Stevens Publishing, 2004.
2. Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
3. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

REFERENCES

1. Wind Energy Engineering *Trevor M. Letcher* ISBN: 978-0-12-809451-8

2. Paul Gipe, “Wind Energy Comes of Age”, John Wiley & Sons Inc., 2000.

3. Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi, “Wind Energy Handbook”, 2nd ed., John Wiley & Sons, 2011.

4. Paul A Lin, “Onshore and offshore wind energy”, Wiley, 2011.

COURSE INFORMATION SHEET

Course code: ME 545
Course title: Solar Passive Architecture
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: 01
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module I - INTRODUCTION

Need for passive architecture - Building form and functions – General aspects of solar passive heating and cooling of buildings – Thumb rules - Thermal comfort – Sun's motion - Building orientation and design – Heat transfer in buildings. (8)

Module II - PASSIVE SOLAR HEATING OF BUILDINGS:

Direct gain – Indirect gain – Isolated gain - Passive heating concept - Thermal modeling of passive concepts – Thermal storage wall and roof – Sunspace – Prediction of heating loads in a building. (8)

Module III- PASSIVE COOLING OF BUILDINGS

Passive cooling concept - Solarium Passive cooling - Ventilation cooling - Nocturnal radiation cooling -Evaporative cooling - Roof surface evaporative cooling (RSEC) - Direct evaporative cooling using drip-type (desert) coolers – Radiation cooling - Earth coupling - Basic principles and systems. (9)

Module IV - CLIMATE AND HUMAN THERMAL COMFORT:

Factors affecting climate - Climatic zones and their characteristics - Urban climate - Microclimate - Implications of climate on building design - Principles of energy conscious

design - Building materials - Embodied energy of building materials - Alternative building materials (8)

Module V - BUILDING RATING SYSTEMS:

Zero energy building concept and rating systems - Energy conservation building codes – Energy management of buildings – Green globe assessment Standards –BREEAM – CASBEE – Green star–Review of CDM Techniques - GRIHA and others. (10)

TEXT BOOKS:

1. Jan F. Kreider, The solar heating design process: active and passive systems, McGraw-Hill, 2007.
2. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
3. N.K. Bansal, G. Hauser, G. Minke. Passive Building Design: A Handbook of Natural Climatic Control. . Elsevier Science. 1994.

REFERENCES BOOKS:

1. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
2. Tom P. Hough, Trends in Solar Energy Research, Nova Publishers, 2006.
3. Source Wikipedia, Books LIc, Solar Architecture: Passive Solar Building Design, Active Solar, Daylighting, Passive House, Cool Roof, Earthship, Solar Air Conditioning, General Books LLC, 2010.
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. S Sukhatme and J Nayak: Solar Energy: Principles of Thermal Collection and Storage, Third Edition, Tata McGraw Hill, 2008.

COURSE INFORMATION SHEET

Course code: ME546
Course title: Hydrogen Energy System
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: 1
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module 1:

Hydrogen properties and production processes: Physical and Chemical properties of hydrogen. Production from fossil fuels, Steam, water. Advanced production methods- production using nuclear energy and renewable, photochemical, photocatalytic, hybrid, etc.

[8]

Module 2:

Hydrogen Storage, Handling & Transportation: Storage Technologies, Compressed hydrogen, Cryo-adsorption, Liquid hydrogen, Slush hydrogen, Underground hydrogen storage, Hydrogen tank, Automotive Onboard hydrogen storage, Hydrogen transportation methods, Challenges associated with hydrogen transport.

[8]

Module 3:

Hydrogen Utilization: I.C. Engines, power plant, gas turbines, hydrogen burners, domestic and marine applications, durability studies, field trials and effect on environment, Current use scenario, eco-friendly nature.

[8]

Module 4:

Advanced Technologies: Fuel cells, Hydrogen Vehicles, Hydrogen Powered Cars, Hydrogen Powered planes, Hydrogen powered rockets.

[8]

Module 5:

Hydrogen Safety: History of accident, Safety barrier diagram, Hydrogen safety codes and standards, Hydrogen sensing, risk analysis, safety in handling, safety management. Hazard spotting and evaluation.

[10]

TEXT BOOKS:

1. M. Ball and M. Wietschel, The Hydrogen Economy Opportunities and Challenges, Cambridge University Press, 2009
2. Ram B. Gupta, Hydrogen Fuel: Production, Transport, and Storage, CRC Press-Taylor & Francis, 2008
3. Peschka, Walter, Liquid hydrogen: fuel of the future, Springer-Verlag Wien, 1992.
4. Kenneth D., Jr.; Edeskuty, F. J. Williamson, Recent Developments in Hydrogen Technology, CRC Press, 1986.

REFERENCE BOOKS:

1. M.K.G. Babu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013
2. Kazunari Sasaki et al. Hydrogen Energy Engineering: A Japanese Perspective-Springer, 2016
3. David Anthony James Rand, Ronald Dell, Hydrogen Energy: Challenges and Prospects, RSC Publishers, 2008

COURSE INFORMATION SHEET

Course code: ME547
Course title: Energy Laboratory I
Pre-Requisite: Basic of Physics, Chemistry and Mathematics
Credits: 2 L: 0, T: 0, P: 4
Class schedule per week: 02
Class: M.Tech.
Semester / Level: 1
Branch: Energy Technology I
Department: Mechanical Engineering
Name of Teacher:

List of experiments:

Experiment 1: To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.

Experiment 2: To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.

Experiment 3: To show the effect of variation in tilt angle on PV module power.

Experiment 4: To demonstrate the effect of shading on module output power.

Experiment 5: To demonstrate the working of diode as Bypass diode and blocking diode.

Experiment 6: Workout power flow calculations of stand-alone PV system of DC load with battery.

Experiment 7: Workout power flow calculations of stand-alone PV system of AC load with battery.

Experiment 8: Workout power flow calculations of stand-alone PV system of DC and AC load with battery.

Experiment 9: To draw the charging and discharging characteristics of battery.

Experiment 10: Comparative performance study solar plan at BIT Mesra.

COURSE INFORMATION SHEET

Course code: ME 548
Course title: Computational Lab
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 2 L: 0, T:0, P:4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: 1/05
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

List of Experiments:

Experiment 1: To simulate a Simple Conduction Problem.

Experiment 2: To simulate a Mixed Boundary Problem (Conduction/ Convection/ Insulated).

Experiment 3: To simulate a Transient Thermal Conduction Problem.

Experiment 4: To do a Coupled Structural/Thermal Analysis.

Experiment 5: To simulate a Conjugate Heat Transfer Problem.

Experiment 6: To prepare a Computational Thermal Model of fluid flow in an elbow.
Experiment 7: To simulate fluid flow across a staggered uniformly-spaced tube arrangement.

Experiment 8: Understanding the simulation using Surface-to-Surface (S2S) Radiation Model.

Experiment 9: Simulation using the Discrete Ordinates Radiation Model.

Experiment 10: To simulate flow around an airfoil.

COURSE INFORMATION SHEET

Course code: EE 597
Course title: Power Generation, Transmission And Distribution
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: 02
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module1:

Generation: Synchronous generator operation, Power angle characteristics and the infinite bus concept, dynamic analysis and modeling of synchronous machines, Excitations systems, Prime mover governing systems, Automatic generation control

[8]

Module 2:

Interface Auxiliaries: Power system stabilizer, Artificial intelligent controls, Power quality

[8]

Module3:

AC Transmission (HVAC): Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Flexible AC transmission

[8]

Module 4:

HVDC transmission: HVDC converters, advantages and economic considerations, converter control characteristics, analysis of HVDC link performance, Multi-terminal DC system, HVDC and FACTS [8]

Module 5:

Distribution: Distribution systems, conductor size, Kelvin's law, performance calculations and analysis, Distribution inside and commercial buildings entrance terminology, Substation and feeder circuit design considerations, distribution automation, Futuristic power generation.

[10]

Text Books:

1. A.J.WoodandB.F.Wollenberg,PowerGeneration,Operation,andControl.John Wiley & Sons, 2003.
2. P.M.Anderson and AA Fouad, Power System Control and Stability, Wiley-IEEE Press, 2002.

References Books:

1 O.I.Elegrad, Electric Energy System Theory: An Introduction, T.M.H. Edition, 1982.
2 C.K.Kim, V.K.Sood, G.S.Jang, J.Lim, J.Lee, HVDC Transmission: Power Conversion Applications in Power Systems, Wiley-IEEE Press, 2009.
3 T.Gonen, Electric Power Transmission System Engineering Analysis and Design, CRC Press, 2009
4 P.Kundur , Power system stability and control, McGraw-Hill, 1994.

COURSE INFORMATION SHEET

Course code: ME 553
Course title: Economics and Planning of Energy System
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: 02
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module-1: INTRODUCTION

Overview of world energy scenario, Overview of India's energy scenario, Economics of various energy conservation schemes. Total energy systems, Basic economic problems. Nature of economics, Positive and normative economics, Micro and macroeconomics, Basic concepts in economics. The role of the state in economic activity, New economic policy in India, Energy economics and its relations with other branches.

(8)

Module-2: ENERGY ECONOMICS

Energy economics - Simple payback period, Discount rate, internal rate of return, Time value of money, IRR, NPV, Life cycle costing, Cost of saved energy, Cost of energy generated, Examples from energy generation and conservation. Energy chain, Primary energy analysis, Life cycle assessment, Net energy analysis. (8)

Module-3: ECONOMICS AND PLANNING

Basics of engineering economics, Relevance of financial and economic feasibility, Evaluation of energy technologies and systems, Financial evaluation of energy technologies, Social cost benefit analysis, Methods for evaluation of tangible alternatives, Replacement analysis, Project feasibility analysis, Marketing feasibility, Technical feasibility, Financial feasibility, Risk analysis and decision trees. (9)

Module-4: ENERGY AND DEVELOPMENT

Energy and development, Role of energy in economic development, Energy intensity and energy elasticity, National and International comparison ,Low, Middle, and High income economies , Role of International institutions – OPEC, OAPEC, IEA, and World Bank. Energy demand analysis and forecasting, Energy investment planning and project formulation, Energy pricing. Policy, planning and implications of energy. Financing of energy systems, Energy policy related acts and regulations. (9)

Module-5: ECONOMICS OF ENERGY SYSTEM

Introduction to economics of energy system, Economics of solar energy systems, Economics of biomass energy systems, Economics of wind energy systems, Economics of ocean energy systems, Economics of geothermal energy systems, Economics of Small-Mini-Micro hydro system, Economics of hydrogen energy systems.

(8)

TEXT BOOKS:

1. M. Kleinpeter, Energy Planning and Policy, John Wiley & sons.
2. C.S.Park, Contemporary Engineering Economics, Prentice Hall Inc.
3. G.D. Ray, Non-Conventional Energy Sources, Khanna Publications.
4. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
5. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK.

REFERENCE BOOKS:

a. J. Parikh, Energy Models for 2000 and Beyond, Tata McGraw Hill Publishing Company Limited.
b. M. Munasinghe and P. Meir, Energy Policy Analysis and Modeling, Cambridge University Press.
c. A.V.Desai, Energy Planning, Wiley Eastern Ltd.
d. H.Campbell and R.Broron, Benefit-Cost Analysis, Cambridge University Press.
e. Frank Krieth& John F Kreider, Principles of Solar Energy, , John Wiley, New York

COURSE INFORMATION SHEET

Course code: ME 554
Course title: Energy Management and Auditing
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: 02
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module-1: INTRODUCTION

Energy and Sources of energy, Energy consumption and GDP, Costs of exploration and utilization of resources, Energy pricing, Energy demand and supply, National energy plan, Need for Energy Policy, National and State level Energy Policies. Basic concepts of Energy Conservation and its importance, Energy Strategy for the Future, The Energy Conservation Act and its Features, Energy conservation in household, Transportation, Agricultural, Service and Industrial sectors, Lighting, HVAC Systems. (9)

Module-2: ENERGY MANAGEMENT

History of Energy Management, Definition and Objective of Energy Management and its importance. Need of energy management, General Principles of Energy Management, Energy Management Skills, and Energy Management Strategy. Energy Management Approach. Understanding Energy Costs, Benchmarking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. Organizing, Initiating and Managing an energy management program. Roles, responsibilities and accountability of Energy Managers. (8)

Module-3: ENERGY AUDIT

Energy audit concepts, Definition, Need and Types of energy audit. Energy Audit Approach and Methodology. Systematic procedure for technical audit. Understanding energy audit costs, Benchmarking and Energy Performance. Energy audit based on First law and Second law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving opportunities, Economic analysis and life cycle costing.Duties and responsibilities of energy auditors. Energy audit instruments and their usage for auditing**.** Report-writing, preparations and presentations of energy audit reports (8)

Module-4: ENERGY CONSERVATION AND ENVIRONMENT

Energy conservation areas**,** Energy transmission and storage, Plant Lecture wise energy optimization Models, Data base for energy management, Energy conservation through controls, Computer aided energy management, Program organization and methodology. Energy environment interaction, Environmental issues, Global Warming, Climate Change Problem and Response, Carbon dioxide emissions, Depletion of ozone layer, Governments Regulations, Energy Economy interaction. Energy Conservation in Buildings, Energy Efficiency Ratings & ECBC (Energy Conservation Building Code)

(8)**Module-5: CASE STUDIES**

Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.) (8)

TEXT BOOKS:

1. Amlan Chakrabarti, Energy Engineering and Management, PHI, Eastern Economy Edition.
2. Smith CB, Energy Management Principles, Pergamon Press, New York.
3. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case study, Hemisphere, Washington
4. L. C. Witte, P. S. Schmidt and D. R. Brown, Industrial Energy Management and Utilization, Hemisphere Publications, Washington.

REFERENCE BOOKS:

1. W.R.Murphy, G.Mckay, Energy Management, Butterworths.
2. C.B.Smith Energy Management Principles, Pergamon Press.
3. L.C. Witte, P.S. Schmidt, D.R. Brown , Industrial Energy Management and Utilization, Hemisphere Publication, Washington
4. Archie, W Culp , Principles of Energy Conservation, McGraw Hill
5. Munasinghe, Mohan Desai, Ashok V, Energy Demand: Analysis, Management and Conservation, Wiley Eastern Ltd., New Delhi.

Program Elective II
(PEII)

COURSE INFORMATION SHEET

Course code: ME 555
Course title: Energy Storage Technology
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: 2
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module 1: Energy Storage
Need of energy storage, Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage. (8)

Module 2: Electrochemical Energy Storage Systems
Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon Nano-tubes in electrodes. (8)

Module 3: Magnetic and Electric Energy Storage Systems
Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon Nano-tube. (10)

Module 4: Sensible Heat Thermal Energy Storage
SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage. (8)

Module 5: Latent Heat Thermal Energy Storage
Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process. (10)

Text Books

1. Robert, Huggins. Energy Storage: Fundamentals, Materials and Applications. Springer Press 2016.

2. Richard Baxter. Energy storage. PennWell Corp. (September 10, 2005). Elsevier

Reference Book

1. Ahmed Zobaa, Energy storage: technologies and applications. Intech Open, 2014

2. David Elliott. Energy Storage Systems. IOP Publishing, Bristol, UK 201

COURSE INFORMATION SHEET

Course code: ME571
Course title: Convection Heat and Mass Transfer
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 **(**L: 3, T: 0, P: 0)
Class schedule per week: 03
Class: M.Tech
Semester / Level:c02
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module1:

Similarity concepts in heat transfer for laminar and turbulent flows; Boundary layer equations; Boundary layer integral equation; similarity and integral solutions of flow over isothermal and non-isothermal flat plate, Numerical solution of the laminar boundary layer flow over a flat plate and viscous dissipation effects on flow over a flat plate. [9]

Module 2:

Introduction to Turbulent Flows: governing equations, mixing length turbulence models, analogy solutions for heat transfer in turbulent flows, near walls region, transition from laminar to turbulent flow, analogy solution for boundary layer flows, numerical solution of turbulent boundary layer equations, viscous dissipation effects on turbulent boundary layer flow over a flat plate. [9]

Module3:

Fully developed pipe and plane duct flow under constant heat flux and constant wall temperature; Pipe flow with developing temperature field; Fully developed laminar flow in ducts with other cross-sectional shapes. [7]

Module 4:

Concept of free convection for vertical, horizontal and inclined plate and cylinders at constant heat flux and constant wall temperature; free convection in finned surfaces and PCBs; free convection in horizontal, inclined and vertical plane enclosures and in horizontal, inclined and vertical concentric cylindrical enclosures. [8]

Module 5:

Significant parameters in convective mass transfer, application of dimensional analysis to Mass Transfer, Analogies among mass, heat, and momentum transfer, Convective mass transfer correlations, Mass transfer between phases, Simultaneous heat and mass transfer. [9]

Text Books:

1. Heat and Mass Transfer, Y. A. Cengel and A. J. Ghajar, McGraw-Hill Education, 2014.
2. An Introduction to convective Heat Transfer Analysis, P. H. Oosthuizen and D. Naylor, 1999.

References Books:

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, John Wiley & Sons, 2006.
2. Convective Heat and Mass Transfer, William M. Kays & Michael E Crawford, McGraw-Hill Science/Engineering/Math, 1993.
3. Principles of Heat Transfer, Frank Kreith and Mark S. Bohn, West Publishing Company, 1993.
4. Heat Exchange Design, D.Q. Kern, McGraw-Hill Book Co., Inc., New York, 1950.

COURSE INFORMATION SHEET

Course code: ME 557
Course title: Integrated Energy System
Pre-requisite(s): Basic physics and mathematics
Co- requisite(s):
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: 02
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher:

Syllabus

Module 1:

Introduction: Pattern of fuel consumption: agricultural, domestic, industrial and community needs.

[8]

Module 2:

Projection of energy demands, Substitution of conventional sources by alternative sources and more efficient modern technologies.

[8]

Module 3:

Potential, availability as well as capacity of solar, wind, biogas, natural gas, forest produce, tidal, geothermal, mini-hydro and other modern applications.

[8]

Module 4:

Hybrid and integrated energy systems, Total energy concept and waste heat utilization, Energy modeling to optimize different systems.

[8]

Module 5:

Power Quality: voltage regulation, frequency matching, Synchroscope.

Application of Power electronics in the Integrated energy System: HVAC to HVDC, MPPT, converter, rectifier and inverter. [8]

TEXT BOOKS:

1. Renewable Energy Sources for fuels and Electricity by Laurie Barrtom.
2. Wind-Diesel Systems by R. Hunter and G. Elliot, Cambridge University Press.

REFERENCE BOOKS:

1. P.Kundur , Power system stability and control, McGraw-Hill, 1994.
2. Dragan Maksimovic, Robert Warren Erickson, Springer, 1997.

Program Elective III

(PE III)

COURSE INFORMATION SHEET

Course code: ME550

Course title: Bioconversion and Processing of Waste

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Credits: 3 L:3, T: 0, P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: 2

Branch: Mechanical Engineering

Specialization: Energy Technology

Name of Teacher:

Syllabus

Module 1:

Introduction: Biomass and solid wastes, Broad classification, Sources of Bio mass, Production of biomass, biomass yield comparison, photosynthesis, world scenario, Environmental effects.
(8)

Module 2:

Biological Conversion: Biodegradation and biodegradability of substrate - Biochemistry and process parameters of biomethanation - Biomethanation Process - Bioconversion of substrates into alcohol - Methanol & ethanol Production - Organic acids – Solvents - Amino acids - Antibiotics etc, agro chemical conversion.
(8)

Module 3:

Other Conversions: Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Enzymatic Fermentation, Gas/liquid Fermentation, Acid hydrolysis and hydrogenation. (8)

Module 4:

Waste processing: Separation of components of solid wastes, handling and processing techniques, composting technique, recycling, Agro and forestry residues utilization through conversion routes, Use of biodegradable waste. (8)

Module 5:

Design and Economics: Economics of biogas plant with their environmental and social impacts, Biogas digester types - Digester design and biogas utilization, Fuel conversion into electricity, Climate change Impact, case studies, Conversion of municipal waste into petrol.

(8)

TEXT BOOKS:

1. S.Samir, R.Zaborsky, Biomass Conversion Processes for Energy and Fuels, New York, Plenum Press, 1981.
2. H.D.Joseph, P.Joseph, H.John, Solid Waste Management, New York, Van Nostrand, 1973.
3. Jianzhong Sun et al. Biological Conversion of Biomass for Fuels and Chemicals: Explorations from Natural Utilization Systems (Energy and Environment Series), RSC Publishing, 2013.

REFERENCE BOOKS:

1. G.Tchobanoglous, H.Theisen, S.V.Tchobanoglous, G.Theisen, H.V.Samuel, Integrated Solid Waste management: Engineering Principles and Management issues, New York, McGraw Hill, 1993.

COURSE INFORMATION SHEET

Course code: ME551

Course title: Solar Photovoltaic System

Credits: 3 L:3, T: 0, P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: 2

Branch: Mechanical Engineering

Specialization: Energy Technology

Name of Teacher:

Syllabus

Module 1:

Fundamentals of Photovoltaic Cells: Solar cell working, General Types, Testing of Solar cells, Materials used for manufacturing, manufacturing processes involved for fabrication, Decreasing cost of PV cells, present scenario, Solar cells, modules, panels and systems.

(8)

Module 2:

Photovoltaic Cells Working: Review of semiconductor physics and Operating principle, Design of solar cells-Cell parameters limits, Losses in solar cells, Solar cell design for high Isc, Voc and FF, PV device characterization. Factors affecting the efficiency of solar cell, Strategies to enhance the efficiency of solar cell. Environmental effects of Photovoltaic. (8)

Module 3:

Solar Cell Technologies: First, Second and Third Generation PV Silicon based technologies. Manufacturing processes (wafer, cell and module) for Solar cells. Concept of multi-junction or tandem

cells, concentrating technologies, Optics for concentrators, PV-Tracking Requirements, High concentrator solar cells.

(8)

Module 4:

Recent Advances: Emerging solar cell technologies (Organic PV, Hetero junction with intrinsic thin film – HIT - Quantum dots - Dye Sensitized Solar cell - Perovskite solar cells etc). (8)

Module 5:

PV Module and PV System Applications: Solar PV system, Batteries for PV systems -DC to DC and DC to AC converters-charge controllers, stand alone, hybrid and grid connected system, Standalone PV systems (Lighting, Water Pumping etc.), Design methodology of PV off grid and grid connected systems, Load estimation and System Sizing, Design of roof top solar PV power plants.

(8)

TEXT BOOKS:

1. Mertens K. ,2013, Photovoltaics: Fundamentals, Technology and Practice, Wiley
2. Solanki C. S. ,2009, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India

REFERENCE BOOKS:

1. Mukerjee A. K. and Thakur N. ,2011, Photovoltaic systems: analysis and design, PHI
2. V Barbec, V.Dyakonov, J. Parisi, N.S. Saricifttci, 2003, Organic photovoltaics: Concepts and realization, Springer Verlag
3. Tiwari G N, 2012, Solar Energy: Fundamentals, Design, Modelling and Application

COURSE INFORMATION SHEET

Course code: ME552

Course title: Nuclear Energy

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s):

Credits: 3 L:3, T: 0, P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: 02

Branch: Mechanical Engineering

Specialization: Energy Technology

Name of Teacher:

Syllabus

Module1 – **Introduction of Nuclear energy:** Nuclear nomenclature, Binding energy and semi-empirical mass formula, Radioactive decay, fission and fusion energy, typical reactions, concepts of Binding Energy of a nuclear reaction, mass energy equivalence and conservation laws, nuclear stability and radioactive decay, radioactivity calculations, Health Hazards: radiation protection & shielding. (8)

Module 2- Interaction of Neutrons with Matter: Compound nucleus formation, elastic and inelastic scattering, cross sections, energy loss in scattering collisions, polyenergetic neutrons, critical energy of fission, fission cross sections, fission products, fission neutrons, energy released in fission, γ-ray interaction with matter and energy deposition, fission fragments. (8)

Module 3- Nuclear fusion and Fission reactions: Fusion reactions, reaction cross-sections, reaction rates, fusion power density, radiation losses, ideal fusion ignition, Ideal plasma confinement & Lawson

criterion. The fission chain reaction, reactor fuels, conversion and breeding, the nuclear power resources, nuclear power plant & its components, power reactors and current status.

(8)

Module 4- Reactor Theory: Neutron flux, Fick's law, continuity equation, diffusion equation, boundary conditions, solutions of the DE, group diffusion method, Neutron moderation (two group calculation), one group reactor equation and the slab reactor.

Plasma Concepts: Saha equation, Coulomb scattering, radiation from plasma, transport phenomena, Plasma Confinement Schemes: Magnetic and inertial confinement, current status.

(8)

Module 5- Nuclear Reactor: Classification of the nuclear reactor and its important Components. Pressurized water reactors (PWR), Boiling water reactors (BWR), Pressurized Heavy Water Reactor (PHWR), Reaktor Bolshoy Moschnosti Kanalniy (High Power Channel Reactor) (RBMK), Gas-cooled reactor (GCR) and advanced gas-cooled reactor (AGR), Liquid-metal fast-breeder reactor (LMFBR), Pebble-bed reactors (PBR), Molten salt reactors, Aqueous Homogeneous Reactor (AHR)

(8)

TEXT BOOKS

1. Nuclear energy by Redman, L.A. 1963, Oxford university press.
2. R.A. Gross, Fusion Energy, John Wiley & Sons Inc., 2008.

REFERENCE BOOKS

1. R. K., Taneja. Nuclear energy, Cyber Tech Publications New Delhi, 2009.
2. F.F. Chen, Introduction to Plasma Physics & Controlled Fusion, Plenum Press, 2004.
3. Weston M. Stacey, Fusion: An Introduction to the physics and technology of magnetic Confinement Fusion, 2nd edition, Wiley- VCH Publication 1984.

COURSE INFORMATION SHEET

Course code: ME559

Course title: Energy, Ecology and Environment

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s):

Credits: 3 L: 3, T: 0, P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: 2

Branch: Mechanical Engineering

Specialization: Energy Technology

Name of Teacher:

Syllabus

Module 1:

Introduction: Connection between energy and environment, Sun as energy source, solar radiation, Biological processes, photosynthesis, Synecology and Autecology. Effect of Population on Ecosystem, Community Ecosystem (wetland, terrestrial, marine), Food chains, Ecosystem theories, biogeochemical and water cycling, terrestrial carbon cycling, Environmental Nanotechnology.

(8)

Module 2:

Sources of energy: Classification of energy sources, Renewable/Non-Renewable Sources, Advantages and Disadvantages of different energy sources, Utilization of different energy sources. Energy, Demand and cost Analysis. Recent advances in energy sector.

(8)

Module 3:

Energy and Environment: Environmental problems linked with harnessing of fossil fuels (coal, oil, natural gas), nuclear energy, hydropower, biomass, solar, geothermal, tidal, wind, Energy flow and nutrient cycling in ecosystems. (8)

Module 4:

Environmental degradation: primary and secondary pollutants, air, soil and water pollution, thermal pollution, radioactive pollution, effect of pollution on climate, Pollution sources, Biological effects of radiation, Acid rain, etc, methods and techniques to study effect of nanoparticles in the environment, Toxicity of the nanomaterial and its possible impacts in the environment . (8)

Module 5:

Environmental Remediation: Waste disposal, Toxic Waste handling, Transportation of fuels and waste, Recycling, Methods to control Nano-particle pollution, Regulations of Industry to control waste, Pollution Control boards (8)

TEXT BOOKS:

1. G. M. Masters, W P Ela, Introduction to Environmental Engineering and Science, Prentice Hall, 3 rd Edition, 2007.
2. Richard Wilson, Energy, Ecology, and the Environment, Academic Press 1974.

REFERENCE BOOKS:

1. D. Nevers, Air Pollution Control Engineering, McGraw Hill, 2001.
2. Nikhil Sharma et al., Air Pollution and Control, Energy Environment and Sustainability Springer, 2017
3. A. Mackenzie, A. S. Ball and S. Virdee, Instant Notes: Ecology, 2nd Edition, BIOS Scientific Publishers Ltd., 2001.
4. F. Armstrong and K. Blunde, Energy Beyond oil, Oxford University Press, 2007.

COURSE INFORMATION SHEET

Course code: ME 558
Course title: Energy Laboratory II
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 2 L: 0, T: 0, P: 4
Class schedule per week: 01
Class: M.Tech.
Semester / Level: 2
Branch: Mechanical Engineering
Specialisation: Energy Technology
Name of Teacher:

Course Objectives

This course enables the students:

A.	Be aware of the immediate market opportunities and challenges in fuel cell systems, and the current state of the art.
B.	Gain hands-on experience of different types of Solar Thermal Energy Systems.
C.	Set the stage for future recruitment by potential employers.

Course Outcomes

After the completion of this course, students will be:

1.	Evaluate performance of fuel cells.
2.	Evaluate the nature of functions.
3.	Analyse the nature of differential equations.
4.	Comparative analysis of numerical methods.
5.	Comparative analysis of numerical integration methods.

List of experiments:

Group 1

1. To solve linear system of equations using Gaussian elimination.
2. To solve linear system of equations using Gauss siedel.
3. To solve linear system of equations using Gauss Jordan.

Group 2

4. Numerical Integration using Trapezoidal rule and Simpson rule.
5. Numerical Integration using Romberg Integration.
6. Numerical Integration using Quadrature formula.

Group 3

7. Finding maxima, minima of multivariable functions.
8. Using least square method for approximation of functions.

Group 4

9. Applying conjugate gradient method.
10. Solving ODE's using numerical Methods.

Group 5

11. Using Euler's Method for solving system of differential equations.
12. Using Runge Kutta for solving autonomous and non-autonomous system of differential equations.

COURSE INFORMATION SHEET

Course code: ME 600
Course title: Thesis Part I
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 2 L: 0, T: 0, P: 4
Class schedule per week: 01
Class: M.Tech.
Semester / Level: 2
Branch: Mechanical Engineering
Specialisation: Energy Technology
Name of Teacher:

COURSE INFORMATION SHEET

Course code: ME 650
Course title: Thesis Project- II
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Credits: 16
Class: M.Tech.
Semester / Level: 4
Branch: Mechanical Engineering
Specialization: Energy Technology
Name of Teacher: